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Optically Relevant Measures of Bottom Roughness: COBOP Data Analysis

Robert A. Wheatcroft
College of Oceanic & Atmospheric Sciences
Oregon State University
Corvallis, OR 97331

phone: (541) 737-3891 fax: (541) 737-2064 e-mail: raw@coas.oregonstate.edu

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LONG-TERM GOALS

The ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for the formation and maintenance of the microtopography (decimeter to millimeter) of the sea floor. To achieve this goal, it is necessary to study formative processes occurring on the sediment surface (e.g., biogenic mound formation, ripple development), as well as processes occurring within the seabed (e.g., bioturbation, compaction) which generally lessen microtopography. The approach to this area of interest is predominantly field-oriented, with a secondary emphasis on model development.

OBJECTIVES

The objective of this project, which is part of the Coastal Benthic Optical Properties (**CoBOP**) DRI, is to study the impact of bottom roughness (biological and physical), bioturbation and near-surface porosity on benthic optical properties. Field studies at sites offshore of Lee Stocking Island, Bahamas, conducted in 1998-2000, yielded a rich set of data. Focus during this biennium is on elucidating the mechanisms leading to the observed patterns of roughness and near-surface porosity.

APPROACH

Measurements of bottom roughness were made using a 35-mm PhotoSea 2000 metric stereocamera mounted on a neutrally buoyant, diver-manipulatable vehicle ("survey") or using a similar stereocamera mounted on a tripod ("time-lapse"). Following standard film development, the images were digitized at a high resolution (i.e., > 4000 ppi) by a third-party aerial mapping firm and stored on CD-ROMs. Sea floor height information is obtained from analytically rectified (epipolar transformation) digital stereo-images using matching algorithms. Independent, co-located measurements of sediment bioturbation intensity and mode are made during the field studies. The bioturbation measurements involve the spreading of glass beads onto a patch of sea floor, followed by tube coring and vertical sectioning after periods of days to months. Tracers were enumerated by dissolving the ambient carbonate grains. Near-bed flow information was collected during the time-lapse deployments using a Sontek ADV. Measurements of near surface porosity were made using an in situ resistivity profiler (IRP).

WORK COMPLETED

Effort during the past year has focused on generating accurate digital elevation models (DEMs) for the time-lapse stereophotographs from North Perry reef. The DEMs were then used to estimate destruction ripple destruction time at the two sites.

RESULTS

The survey DEM data clearly indicate differences between the roughness near (i.e., 0-5 m) versus far (> 50 m) from the North Perry reef. In particular, the far-reef seafloor height spectrum exhibits significant low-frequency energy that corresponds to the wavelength of relict wave ripples. In contrast, the near-reef roughness is dominated by biogenic microtopography, especially animal mounds (10-cm width). Independent estimates of vertical bioturbation rates and modes (e.g., diffusive vs. nonlocal) for the near versus far reef sites are approximately equal, suggesting potential anisotropic mixing (i.e., horizontal rates may differ at the two sites).

Time-lapse stereophotographs have been analyzed to estimate the destruction rate of ripples near and far from the North Perry reef. Although there is much variability, and a small sample size, the results confirm that the residence time of ripples is longer far from the reef (i.e., near-reef ripples are destroyed more rapidly).

IMPACT/APPLICATIONS

The development of a photographic system capable of quantifying sea floor microtopography is likely to have widespread application in oceanography. For example, studies of sediment transport and acoustical interactions with the sea bottom would both benefit from knowledge of the short-term evolution of bottom roughness.

RELATED PROJECTS

The seafloor DEM data are being shared with E. Boss (University of Maine) to help in his study of roughness effects on bottom reflectance. In addition, the ADV data from North Perry and the Rainbow Gardens South closure site were shared with Boss, D. Burdige (Old Dominion University) and K. Voss (University of Miami) for various purposes. Lastly, M. Allison (Tulane University) and I are collaborating on the influence of near-surface porosity on light penetration.

PUBLICATIONS

Wheatcroft, R.A. 2002. *In situ* measurements of near-surface porosity in shallow-water marine sands. *IEEE Journal of Oceanic Engineering*, 27: 561-570.

Decho, A.W., T. Kawaguchi, M.A. Allison, E. Louchard, C. Stephens, R.P. Reid, K. Voss, R.A. Wheatcroft, B. Taylor. 2003. Sediment properties influencing up-welling spectral reflectance signatures: The "biofilm gel effect" *Limnology and Oceanography*, 48: 431-443.